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ABSTRACT

This paper contains a reaction to another paper that discusses possibilities for reforming mathematics education and social justice. The author identifies the conceptualization that the pathways that students take through mathematics should be meaningful and lead to productive lives in the new labor market. The hegemony of mathematics education as a traditional pedagogy informed by transmission models of teaching, the current push in education based on economic rationalism where discourses are based on accountability, and the need to ensure that the employing bodies and other interested parties, and the extended notion of pathways as a possibility for reform in mathematics education are discussed. (KHR)

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Pathways: Possibilities for Reform and Social Justice

A Reaction Paper to Smith

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From Smith's paper, I understand him to be raising a number of points. First, that the pathways that students take through mathematics should be meaningful and lead to productive lives in the new labour markets. He suggests that the old forms of mathematics teaching are not as effective as they should be and that there is a need for reconceptualising the teaching of mathematics if it is to be made accessible to all rather than the hegemonic practice that we are, at this conference at least, critically aware. In posing his challenge to mathematics educators that there is a need to develop more effective pedagogical forms that will enhance equity outcomes, three key considerations come to mind. In the first instance, the hegemony of mathematics education as a traditional pedagogy informed by transmission models of teaching must be considered. The discourses informing mathematics education are dominant and very resilient to change. Many teachers in the primary sector tend to be uncomfortable with mathematics and rely on traditional pedagogical forms whe teaching this subject more so than with other subject areas. Effecting change in such contexts is difficult. The second issue deals with the current push in education based on economic rationalism where the discourses are based on accountability and the need to ensure that the employing bodies and other interested parties are receiving value and return for their expenditure. Current estimations would indicate that the return from the equity dollar is perceived to be low and that social justice money is not being effective. The third and final issue deals with the notion of pathways. This is central to Smith's paper, but it is not extended in a way that is possible given his "optimistic futures" perspective. I would propose that contemporary education is in a critical phase due to the substantial changes occurring within schools and the wider society. The schooling system was designed for the modern society, but it is evident that there is significant change and that the needs and learning patterns of contemporary students are very different from previous generations. Schools and mathematics education need to be changed significantly in order that we cope with the demands of the new millenium. The notion of pathways provides a means through which this is possible, but Smith's notion needs to be extended.

Pathways and Mathematics Education

The role of mathematics in subject choices and life trajectories has been understood for some time. It had its birth with the reforms in the gender equity. The movements in gender reform highlighted the importance of more girls undertaking the study of mathematics. What became clear was that not only were girls not participating in mathematics, that where they were participating, they were not taking the "right" mathematics. Their subject choices could lead to them into better careers where there were greater social and economic rewards if they took the "right" forms of mathematics. For example, to gain entrance into medicine or veterinary science, girls needed to take the more complex forms of mathematics rather than general forms mathematics. As the focus moves away from gender, it is now recognised that other groups in society are equally marginalised through their lack of participation and success in the "right" forms of mathematics. This approach to pathways seems to be central to Smith's conceptualisation of the same.

There have been a number of studies that track the effects of non-participation in mathematics for social justice target groups (such as working-class students, girls, and racially-marginalised students). Not only must participation be considered, but also

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success and retention. Such studies have shown the low participation, low success and/or low retention rates of target students. Within dominant discourses in mathematics education, the focus has been on individual characteristics such as motivation, self esteem, attributions of success and failure, and so forth. Such approaches engender a victim-blaming mentality that fails to account for the structural exclusion of students. One of the themes of this conference is to bring to the fore, discussions that critically appraise the forces that help to exclude students from mathematics. Smith poses a challenge to the mathematics education community to examine mathematics pedagogy more critically for the ways in which invisible pedagogy (Bernstein, 1990) acts "selectively on students from different backgrounds" (Smith, 2000, p. 12). His call to make mathematics pedagogy transparent for all students and to prepare them for the real world is a very realistic argument and one which we should consider seriously.

Mathematics Education and Resistance to Change

I would find it difficult to believe that there is a mathematics educator, particularly at this conference, who believes that mathematics pedagogy is not in need of renewal in some form or another. While social justice outcomes may not be the focus for all mathematics educators, it is certainly a key focus for this conference. Indeed there are ample studies that highlight the need to for innovative practice and a plethora of studies that show how students learn a range of mathematical concepts and processes. Our counterpart conferences are imbued with such studies, yet they have made little inroad into reconceptualising mathematics pedagogy. By and large, the teaching of mathematics has remained a conservative practice that is still dominated by traditional practices. This is in spite of the large number of studies (and money) that has been spent on identifying quality practice and attempts at improving practice in order to improve social justice outcomes. This begs askance of why this is so.

Anyone associated with initial teacher education will attest the resilience of traditional teaching methods. In providing preservice teachers with the knowledge of new approaches to teaching mathematics, two forces appear that impeded reformed teaching methods. In the first instance, primary preservice teachers have generally avoided the study of mathematics so have resistance to the subject and very poor perceptions of it. As a consequence, they often rely on their history to position their thinking and practice of mathematics education. In the second instance, they place a high priority on the value of practice so their school practice experiences are seen to be invaluable in their formation of ideas about effective teaching and learning. Yet in most cases, they report that these experiences are the antithesis of what they experience at the university level. Over a period of three years, I have surveyed my third year students (in a four year Bachelor of Education degree) and sought to identify the types of experiences they have had in their practicums insofar as the teaching of primary mathematics. The response has been anywhere between 86% to 95% (depending on the cohort) that they have had traditional teaching experiences across their last three practicums. Sullivan and Mousley (1993) have noted that there needs to be some caution in using interpretations of teachers' practice due to the subjective framework within which such interpretations are made. However, the qualitative descriptions provided by the students indicate that their experiences are significantly traditional forms of pedagogy when it comes to teaching mathematics. As such, the practices of the past - "chalk and talk", "teacher directed maths", rote and drill, are very evident in the students' experiences. What is disconcerting is the high number of students who claimed to have observed only traditional forms of mathematics education thus suggesting that the practice is very common.

Furthermore, there were numerous comments that the supervising teachers did not give university studies much credence within the school experience. Many students recanted that their teachers would comment that university studies had little to do with what happens in the reality of the classroom. Together, these comments suggest that the reality for preservice teachers and the students in mathematics classrooms are ones where there is a resistance to change. Some of the comments offered by the students included:

S1: My teacher said that the stuff we learnt at Uni had nothing to do with what happens in the classroom. All the stuff like constructivism, group work, and that didn't work and that it was best just to forget what we learnt there and do like they do in schools. At least we know it works.

S2: When I was on prac my teacher said that the uni lecturers really have no idea what is happening in the classroom. She said that you really can't do all that fancy teaching that we learn at Uni. It doesn't work and that we are better to forget it and just get on with teaching. She said it was fine to have all that theory, but it really doesn't help much in the classroom.

S3: My last teacher was very old fashioned. She said that everything just goes around in circles. She has seen it all before and it really doesn't make any difference. She reckons that once you come out of uni you have too many things to do and that the only way to survive is to do it the traditional way. It has always worked so why bother with the other stuff. In the end it will come back again [to traditional teaching].

S4: My last teacher had only been teaching for a few years so I was surprised by her comments about how to teach maths. She used the textbooks a lot. She said that she never felt confident teaching maths and she did not do so well at uni. She reckons that the textbooks are really good as they have books for the teachers and they [the books] give you ideas on how to teach the content to the kids. She says she tries something new from time to time, but she only uses a little bit of the problem solving stuff that she learnt at uni. She said her lecturer at uni was down on textbooks but she has found that they work really well.

The comments selected above indicate teachers' resilience to change. Equally, they indicate the almost futility of change within preservice education. Where practicum experiences assume a very high profile, the denigration of new ways of teaching (based on research) allows many preservice teachers the opportunity to legitimately reject the contemporary approaches to teaching mathematics. In so doing, it makes implementing change quite difficult. Similar comments were made in relation to assessment. Again, the research that has shown that traditional pencil-and-paper testing is not an effective means of assessing student understanding but that this has not filtered down into classroom practice.

S5: My teacher did the Friday tests. That way she can work out who has learnt what they were taught during the week and who hadn't. She said that the other ways of assessing kids' work is all fair and good, but it takes too much time and as a teacher, there is too much going on to be doing all the other things.

These comments are representative of the majority of comments offered by the students. There were some students who were fortunate enough to experience more innovative practices, but they were in the minority.

When these experiences are coupled with the past experiences of the students and their fear of mathematics, there is a strong tendency to rely on past methods rather than embracing new reforms. The teachers' comments help to reinforce the values held by the students and as such legitimate past practices. Given that prac is seen as such a valuable component of initial teacher preparation, the comments offered by students and the results of these surveys suggest that the capacity to effect change in the teaching of mathematics is restricted. As such reproduction of old values inherent in past methods remain dominant.

Considerable research has been undertaken by members of the mathematics education research community that notes the need and value of reform in mathematics teaching. The

wide scale reform proposed by the National Council of Teachers of Mathematics (1991) has not been implemented as effectively as would have been hoped. For example, Frykholm (1996) noted the difficulty in translating the standards into practice.

Bourdieu's (1992) notion of field is most useful in trying to understand this phenomenon. For Bourdieu, field is an arena where relationships of power are negotiated and lived out. Within the field of education, of which mathematics education and schools are subsets, there are certain practices that hold more sway than others at particular points in time. These are not fixed but can be quite transitory in nature. For example, in mathematics education, the discourse of constructivism was quite powerful in the past decade. Those who purported to support the discourse gained more power through such links. This power was achieved through the symbolic power conveyed through the field which, in this case, could be attained through objects such as publications (journal articles, books, etc), conference keynotes which were then convertible to other forms of capital, including economic capital, through forms such as promotions, royalities and so on. For teachers entering the school system, power is conveyed through the discourses that dominate school education. For preservice teachers, this means that they need to demonstrate the qualities desired by the teaching profession in order that they gain entry into the profession. For such students, this may be in the form of professional interviews where the prospective employee must demonstrate the qualities demanded by the profession. Those prospective teachers who do not show the characteristics desired by the employing body are less likely to gain employment than their peers who show such characteristics. Accordingly, the preservice teacher must comply with the unspoken rules of the field and assume the qualities of a good teacher. In this case, it may well be that the employing school sees quality mathematics teaching within traditional discourses so that the prospective employee needs to demonstrate these qualities in order to gain employment with this school.

However, the previous discussion revolved around the primary sector and questions need to be asked as to the effect in the secondary sector. In the past, teachers entering secondary school classrooms could be considered to have a reasonably strong grasp of mathematics. However, this is not necessarily the case in contemporary schooling. In their study of mathematical knowledge of secondary teachers, Kanes and Nisbet (1994) found that many teachers did not have a strong knowledge base and indeed, many teachers were being given mathematics classes to fill their teaching quota even though they were not qualified in the discipline. This finding suggests there is a strong synergy between the primary and secondary sectors than would have been expected in the past. This situation is likely to worsen with less people seeking teaching as a career and even less undertaking the study of mathematics. It is highly likely that many teachers facing junior secondary classes may be very similar in profile and attitudes towards mathematics as their primary school peers.

Accountability and Teacher Change

In this section, I take up the issue raised by Smith insofar as the moves towards accountability in education. One of the ethical dilemmas in researching educational failure is the effect on teachers and their standing in the community. One must be very careful so as not to engender teacher bashing as teachers and schools are often blamed for all manner of social ills. This is hardly fair. However, as Smith also notes, the issue of accountability is a key to educational change. Whereas other professions are held accountable for their actions, traditionally teachers have not. In a large-scale study of American teachers, it was found that newer teachers were more effective than teachers of 20 years in the field, producing better learning outcomes than their more experienced peers (The Australian, Jan 29, 2000). Using test results across a number of years, researchers were able to identify individual teachers and schools that were more or less effective than others. They claim that there were teachers who are not improving (or in some cases detracting from) student learning, and such teachers should be held accountable for their teaching. This is a relatively new phenomenon and has met with considerable debate. Where the results are

being used to control teachers, there is a need for criticism but where the scores are being used to identify consistently poor teachers, there may be some merit in the process.

Current moves in education have focused on accountability through wide scale measuring schemes. The rhetoric behind such schemes has been to identify and monitor student progress, and where necessary, implement necessary educational programs to enhance student learning. However, as is often the case, such rhetoric can appear to be empty and a thin veil for controlling education. There is a need for healthy cynicism for such programs. However, if the programs were designed for social justice purposes and indeed, if there were systemic problems noted and redressed, then there is some value in having such programs. For example, in the Australian context, indigenous students consistently scored significantly lower than non-indigenous students . Similar studies have shown the same results in the United States (Reyes & Stanic, 1988; Secada, 1992). Such systemic failure must be addressed. The problem has been long standing. Whereas the gender reform initiatives have had a considerable impact on educational outcomes, there has been significantly less impact for students from socially disadvantaged backgrounds or students from particular racial backgrounds.

If the results of such tests continue to show poor performance, then there is a need for some intervention. It is unjust that disadvantaged students can continue to be excluded from curriculum studies. However, where the programs are used in contexts for pegging salaries or closing schools, then they [the programs] should be called into question. As has occurred in the UK, schools in disadvantaged areas have performed poorly on testing scales and were closed due to poor performance. Little consideration had been given to the demographics and special needs of the students, but rather, the schools have been closed for political reasons and the schools have been used as scapegoats for wider systemic problems.

One of the difficulties in mathematics education has been the dominance of particular forms of knowledge and pedagogy even though research has shown such practices to be inequitable. In part, this is due to the values (and fears) that some teachers hold towards mathematics. One of the dangers of being critical of the teaching of mathematics is that it can engender teacher bashing. Hence many studies of mathematics teaching are couched in terms of effective teaching and seek to identify effective teachers of numeracy or mathematics. In their large scale study, Askew et al (199?) identified a number of features of good teachers of mathematics. In so doing, it implicitly suggests that those teachers who do not have the characteristics identified in the study may not be as effective.

One of the characteristics noted by Askew et al (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997) is the involvement in professional development. Such characteristics include undertaking regular, sustained and focused professional development. That is, professional development that improves the education and deep learning of the teacher as opposed to the hands-on, half day, inservices often taken by teachers. The latter forms of professional development do little to improve teachers' understanding of teaching and learning, but rather give access to quick lessons that can be implemented with little understanding of the links between other aspects of the mathematics curriculum – a further quality of good teachers identified in the Askew et al (1997) study. Indeed, the resistance to change has been borne in studies where teachers theorised their work and it was found that how they talked about their work could be correlated with when they undertook their initial teacher training (Andrews, 1997). Thus is would appear that teachers must undertake sustained study in order that they move with the times and gain a currency in their work. By invoking some forms of accountability, teachers may need to undertake the forms of professional development advocated by Askew et al (1997) in order to ensure that they are up to date with current research and approaches to effective teaching and learning.

Many education authorities are seeking accountability in some aspects of teachers' work – namely student performance, yet if they are serious about teacher improvement and moving teacher perceptions beyond the comments offered in section one, then the work by Askew et al suggests that there is some rationale for teachers to undertake effective forms of professional development. Furthermore, if this is indeed the case that good teachers of mathematics are those who undertake such forms of professional improvement then

employers need to recognise teachers who are undertaking forms of professional development that enhance learning outcomes for students, and in so doing improve the status of schools, education and society.

Pathways and Social Reform

Smith has noted that the pathways undertaken by students in their study of mathematics are critical to their life chances. Not only does he advocate undertaking the right mathematics, but that the mathematics that is undertaken should be meaningful and purposeful in the reformed labour markets. This is a very valid observation and one that has been noted by a number of key researchers. Changes to the nature of work mean that Marxist conceptions no longer hold the sway that was evident in modern society. The labour market trends that he notes bear testimony to the changed workplace and the need for graduates for these positions. In concert with the changed workplace, is the role of high retention rates. Using Giddens (1999), Smith argues that education to Year 12 improves job prospects, earning capacity and social gains including greater social cohesion, lower crime and better health. Lamb [REF NEEDED] has shown similar findings in his longitudinal work of Australian school leavers. Lamb's analysis of school subject choices has shown the role of mathematics in the student subject profile to be a critical factor in subsequent life successes. These studies show categorically that students need to complete 12 years of schooling in order to maintain a reasonable to high quality of life. Thus, it is in a society's and the individual's best interest to keep students in the education system as long as possible. However, some caution is needed. Not only is completion of Year 12 an indicator of improved life chances, the choices of subjects within the suite of year 12 subjects must be considered.

Lamb's comprehensive analysis of subject choice alerts us to the potential for a ghetto-ising effect of choices. Clearly the choice of mathematics is critical to improving life chances, but as Lamb (1997) and Teese (Teese, Davies, Charlton, & Polesel, 1995) both argue, it is not only mathematics that is important, but the type of mathematics. Based on subject selection across various social, cultural and gender groups, the patterns of subject selection are noticeable. It is more likely that working-class (or low SES) students are likely to select the soft options – general maths and biology – whereas middle-class (or high SES) students are more likely to select the "hard options" maths B and C (which contain topics such calculus, trigonometry etc) physics and chemistry.

However, these pathways represent traditional forms of knowledge packaged within traditional modes of pedagogy. Clearly subject choice needs to be more informed, but it assumes a particular form of rationality in subject choice. This is not always the case, and maybe subjects are chosen for personal or subjective reasons, some of which will bear significantly on life chances, but not all students chose for the seemingly logical choices. Subjects may be chosen because the student likes a particular person or that it is the only subject of any interest in a particular block of subjects within the timetable. However, the old structures of schooling remain intact. What may be necessary is a total reconstruction of curriculum and modes of delivery. The debate about boys and education has brought to the fore many of the issues about the suitability of contemporary practices for the post modern students. Many students would consider taking on more employment during school hours so that there is a need for more flexible school hours. Students may be able to undertake practical studies in their nominated curriculum areas. It may be useful for students considering engineering as a career to undertake field work and see how the mathematics is used within the workplace and see the relevance of the mathematics in situ and also to observe how engineers undertake the calculations necessary within particular contexts. Often teachers do not have this hands-on knowledge so the mathematics becomes deconstextualised. Examples used in classrooms are often ones that are used repeatedly so students do not gain the knowledge necessary for the applications to the field.

Where students are struggling with mathematics and school in general, there maybe some usefulness in allowing them greater flexibility within their study programs. It is not uncommon for early school leavers to resume study at vocationally-orientated colleges.

These colleges have developed curricula more suited to the needs of the less-academically orientated students, but students gain significantly more from these learning environments than their school experiences. In part, it is the pedagogical approaches used by the teachers, but it is equally the case that many students see the colleges as a second chance to improve their employment opportunities. Different pathways through school may be able to encapsulate these flexible forms of delivery. Students maybe able to engage in part time work in the very casualised workplace and come to realise that this type of employment is not desirable. In so doing, they may be able to remain in school study, in a reduced capacity, but undertake study within the school context that supports their employment while enhancing their job opportunities. For example, the student working in the casualised retail industry may undertake work on the shop floor or cash register while remaining at school but undertaking studies in retail management. Subjects, often perhaps in a modularised form, support and extend the activities of the workplace and in so doing, give the students a chance to see the relevance and applicability of the school studies.

Towards a Socially-Just Mathematics

Smith (2000, p. 12) advocates the need to provide "school leavers with the ability to use mathematics-based tools without requiring that they prepare from mathematics-based careers". This would seem to be a reasonable enough claim as most students do not pursue tertiary mathematics as a career. Rather, as mathematics educators in this sector bemoan, fewer students are undertaking sustained studies in mathematics. Rather, tertiary mathematics is of the form where students drop in and out of subjects as they need to fill in quotas for other courses. Smith appears to be advocating for a mathematics curriculum that enables students to think mathematically rather than being able to recite meaningless formulae. By providing all students with the capacity to think mathematically, they should be competing on a more equal playing field than has been done in the past. This is the dream of most mathematics educators, but it is far from being realised. We are acutely aware of the need for more students to have access to mathematics as it is a powerful tool for contemporary society – in terms of employability as well as quality of life. We know from situated cognition studies that people undertake tasks in a variety of ways, most of which are not like those that are taught in formal school mathematics. Yet, equally we are acutely aware that the power of thinking mathematically about such tasks is often more efficient, effective and accurate than the methods developed *in situ*. For example, Lave et al's (Lave, Murtaugh, & de la Rocha, 1984) shoppers who needed to check the price of cheese could have calculated the price of the cheese using ratio and proportion, but had to rely on a seek and search technique to find other balls of cheese the same mass and then compare prices. The ability to think mathematically in these situations has the potential to be far more empowering than the methods used. However, it is not always the case, and invented algorithms can be just as effective when they have meaning to the inventors such as the street vendors in Carraher, et al's work (Carraher, 1988; Carraher, Carraher, & Schliemann, 1985).

We are acutely aware also of the routinised ways in which mathematics frequently is taught to students. Students are taught particularised steps in solving mathematical tasks. As Bourdieu would argue, such practices come to be embodied by the students within a mathematical habitus. This habitus, in turn, provides the lens through which students come to see and interpret the mathematical world. For many of them, mathematics is little more than lock-step processes which they need to follow in order to solve tasks. This process does little to develop deep understanding of the mathematics. As such, practices such as these tend to be mathematically disempowering for students.

In conclusion, I support Smith's claim that there is an urgent need for reform in mathematics that will make it accessible for more students and that such mathematics will meet the needs of the reformed market place. In order that we achieve these changes, there are obstacles to be addressed. I have highlighted some of these. What is essential is that the changes that do need to occur and that will move mathematics pedagogy away from the exclusory practices of the past, must be supportive. Teachers live in very demanding contexts. As Michael Apple's (Apple, 1995; Apple & Jungck, 1992) work attests,

teachers' work is intensifying and they are at risk of having many of their professional responsibilities removed, so it is critical that many of the professional decisions that teachers make in relation to student performance and progress are protected. Teachers need to be supported in the current climate where there are increasing demands if they are to be able to adopt and adapt to new forms of mathematics pedagogy, particularly those highlighted in this session where the aim is to be more inclusive.

The simplistic (and outmoded) model of teacher education that I proposed in relation to my students' experiences during practicum experiences highlights the weakness in such models of teacher education. Perhaps there is potential in breaking down the school/university dualism, and that the professional development of preservice teachers, school teachers and university teachers is undertaken as a learning team, where each learns from the other. This may support teachers in developing new forms of socially-just pedagogy; may provide university staff with insights and understandings of contemporary classrooms along with increased understandings of the effectiveness of these proposed reforms; and to break down the dichotomy and tensions that preservice teachers experience during their initial training. This may give legitimacy to both practice and theory and in so doing bring about informed practice for all participants.

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